(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号

特開平8－263678

(43)公開日　平成８年(1996)10月11日

(51)Int.Cl.⁶	識別記号	庁内整理番号	ＦＩ		技術表示箇所
Ｇ０６Ｔ　11/80			Ｇ０６Ｆ　15/62	３２０Ｌ	
Ｇ０６Ｆ　17/50			15/60	６２６Ｇ	

審査請求　未請求　請求項の数４　ＯＬ　（全９頁）

(21)出願番号　特願平7－34900

(22)出願日　平成７年(1995)２月23日

(71)出願人　000003997
日産自動車株式会社
神奈川県横浜市神奈川区宝町２番地

(72)発明者　井上　博順
神奈川県横浜市神奈川区宝町２番地　日産自動車株式会社内

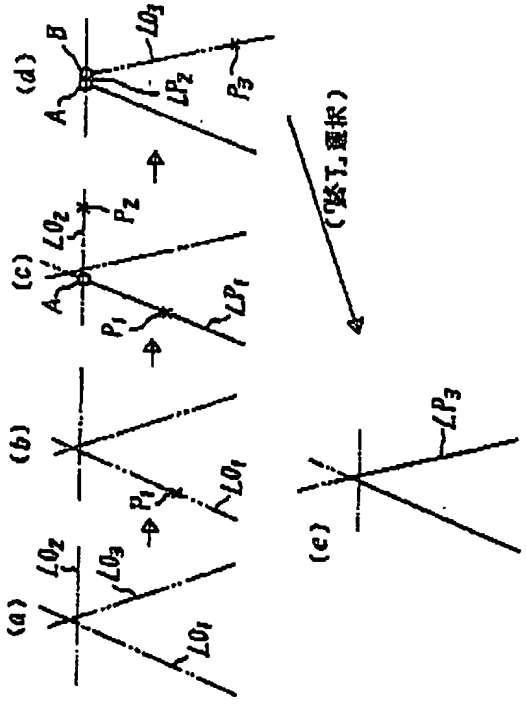
(74)代理人　弁理士　杉村　暁秀　（外５名）

(54)【発明の名称】　複数曲線の連結方法

(57)【要約】

【目的】　何本かの曲線で取り出す範囲が短い場合でも大まかな位置のピックで必要な形状の一本の連結曲線を取り出し得るようにすることを目的とする。

【構成】　ＣＡＤシステムで、ピックにより複数の曲線LO_1 ～LO_3 の各々の所定範囲を取り出し連結して一本の曲線LP_3 を取り出すに際し、最初にピックした曲線LO_1 ではその曲線のピック位置P_1側の端点からその曲線LO_1 と次にピックした曲線LO_2 との交点Ａまでの間の範囲を所定範囲として取り出し、最後にピックした曲線LO_3 ではその曲線と前にピックした曲線LO_2 との交点Ｂからその曲線LO_3のピック側の端点までの間の範囲を所定範囲として取り出し、上記最初と最後にピックした曲線を除く各曲線LO_2 ではその曲線と前にピックした曲線LO_1 との交点Ａからその曲線と次にピックした曲線LO_3 との交点Ｂまでの間の範囲をその曲線LO_2 の所定範囲として取り出すことを特徴とするものである。



【特許請求の範囲】

【請求項１】　ＣＡＤシステムを用いて、複数の曲線をピックしてそれらの曲線の各々の所定範囲を取り出し、それら所定範囲の曲線を連結して一本の曲線を取り出すに際し、

前記ピックした複数の曲線の内の最初にピックした曲線については、その曲線のピック側の端点から、その曲線とその次にピックした曲線との交点までの間の範囲を前記所定範囲として取り出し、

前記ピックした複数の曲線の内の最後にピックした曲線については、その曲線とその前にピックした曲線との交点から、その曲線のピック側の端点までの間の範囲を前記所定範囲として取り出し、

前記ピックした複数の曲線の内の前記最初および最後にピックした曲線を除く各曲線については、その曲線とその前にピックした曲線との交点から、その曲線とその次にピックした曲線との交点までの間の範囲を、その曲線の前記所定範囲として取り出すことを特徴とする、複数曲線の連結方法。

【請求項２】　前記ピックした複数の曲線の内のある一本の曲線とその前にピックした曲線との間で複数の交点が存在する場合には、それら複数の交点の内の前記一本の曲線のピック位置に近い交点を、前記一本のピックした曲線とその前にピックした曲線との各々の前記所定範囲を定めるための交点とすることを特徴とする、請求項１記載の複数曲線の連結方法。

【請求項３】　前記ピックした複数の曲線の内のある一本の曲線とその前にピックした曲線との間で複数の交点が存在するとともに、それら複数の交点間の距離の最小値が所定値以下の場合には、それらの交点が互いに所定距離内のものであることを表示して、それらの交点の内のユーザーが選択した交点を、前記一本のピックした曲線とその前にピックした曲線との各々の前記所定範囲を定めるための交点とすることを特徴とする、請求項２記載の複数曲線の連結方法。

【請求項４】　前記ピックした複数の曲線の内のある一本の曲線が閉曲線の場合には、その閉曲線とその前にピックした曲線との交点からその閉曲線とその次にピックした曲線との交点までの間の範囲の内のユーザーが選択した範囲を、その閉曲線の前記所定範囲として取り出すことを特徴とする、請求項１から請求項３までの何れか記載の複数曲線の連結方法。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】この発明は、コンピュータ支援設計（ＣＡＤ）システムを用いて、複数の曲線（この明細書では直線も含む）をピックしてそれらの曲線の各々の所定範囲を取り出し、それら所定範囲の曲線を連結して一本の曲線を取り出す際に用いて好適な、複数曲線の連結方法に関するものである。

【０００２】

【従来の技術】ＣＡＤシステムを用いて、複数の曲線の各々の所定範囲を取り出し、それら所定範囲の曲線を連結して一本の曲線を取り出す場合には、一般にＣＡＤシステムのユーザーが、それら複数の曲線について順次にピック（マウスの移動操作等でポインタを曲線上に移動させて、マウスのボタン操作等でそのポインタを置いた曲線を指定する作業）を行って、それらピックした曲線の所定範囲同士を連結した曲線をＣＡＤシステムに取り出させるが、そのピックによってＣＡＤシステムが各曲線からそれぞれ取り出す上記所定範囲は、従来はＣＡＤシステムが、曲線同士の交点とピック位置とに基づいて決定している。

【０００３】例えば図７に示すように、同図(a) に示す三本の曲線LO_1, LO_2, LO_3 をピックして同図(d) に示す１本の曲線LP_3 を取り出す場合には、ユーザーが先ず、同図(b) に示すように元の曲線LO_1 上の位置P_1をピックして、ＣＡＤシステムに曲線LP_1 を取り出させ、次いでユーザーが、同図(c) に示すように元の曲線LO_2 上の位置P_2をピックすると、ＣＡＤシステムが、曲線LP_1 と元の曲線LO_2 との交点Ａの位置で曲線LP_1, LO_2をそれぞれ分割し、その分割後の曲線の内のピック側（曲線LP_1 は位置P_1側、曲線LO_2 は位置P_2側）を連結して、新たに曲線LP_2 （ピック位置はP_2とする）を作成する。その後ユーザーが、同図(d) に示すように元の曲線LO_3 上の位置P_3をピックすると、ＣＡＤシステムが、上記と同様交点Ｂで曲線LP_2, LO_3を分割してピック側を連結することで、一本の曲線LP_3 を取り出す。

【０００４】

【発明が解決しようとする課題】しかしながら、ＣＡＤシステムにおけるピックの精度上、ユーザーが元の曲線の狭い範囲を正確にピックするのは困難で、所望の位置を正確にピックするためには繰り返しトライを行う必要があり、ピックが不可能な場合もある。これがため、上記従来の、交点とピック位置とによって取出し範囲を決定する方法では、取り出し範囲が短い曲線については正しく連結できない場合がある。

【０００５】すなわち例えば図８(a) に示すように、元の曲線LO_1, LO_2, LO_3 の交点同士が近接しているような場合には、同図(b) に示すように元の曲線LO_1 をピックして曲線LP_1 を取り出させた後、同図(c) に示すように元の曲線LO_2 をピックして曲線LP_2 を取り出させる際に、元の曲線LO_2 の、曲線LO_1, LO_3との交点Ａ，Ｂ間の範囲が極めて短いためその交点Ａ，Ｂ間で曲線LO_2 をピックすることが困難あるいは不可能となり、これがため例えば同図(c) に示すように交点Ａ，Ｂ間から外れた位置P_2をピックしてしまうと、ＣＡＤシステムが、交点Ｂに対しピック側である上記外れた位置P_2側の曲線LO_2 を曲線LO_3 に連結して曲線LP_3 を取り出してしまうので、ユーザーが、必要な形状を取り出すことができない。

【０００６】
【課題を解決するための手段】この発明は、上記課題を有利に解決した連結方法の提供を目的とするものであり、この発明の複数曲線の連結方法は、ＣＡＤシステムを用いて、複数の曲線をピックしてそれらの曲線の各々の所定範囲を取り出し、それら所定範囲の曲線を連結して一本の曲線を取り出すに際し、前記ピックした複数の曲線の内の最初にピックした曲線については、その曲線のピック側の端点から、その曲線とその次にピックした曲線との交点までの間の範囲を前記所定範囲として取り出し、前記ピックした複数の曲線の内の最後にピックした曲線については、その曲線とその前にピックした曲線との交点から、その曲線のピック側の端点までの間の範囲を前記所定範囲として取り出し、前記ピックした複数の曲線の内の前記最初および最後にピックした曲線を除く各曲線については、その曲線とその前にピックした曲線との交点から、その曲線とその次にピックした曲線との交点までの間の範囲を、その曲線の前記所定範囲として取り出すことを特徴とするものである。
【０００７】なお前記ピックした複数の曲線の内のある一本の曲線とその前にピックした曲線との間で複数の交点が存在する場合には、それら複数の交点の内の前記一本の曲線のピック位置に近い交点を、前記一本のピックした曲線とその前にピックした曲線との各々の前記所定範囲を定めるための交点とすることとしても良い。
【０００８】また前記ピックした複数の曲線の内のある一本の曲線とその前にピックした曲線との間で複数の交点が存在するとともに、複数の交点間の距離の最小値が所定値以下の場合には、それらの交点が互いに所定距離内のものであることを表示して、それらの交点の内のユーザーが選択した交点を、前記一本のピックした曲線とその前にピックした曲線との各々の前記所定範囲を定めるための交点とすることとしても良い。
【０００９】さらに前記ピックした複数の曲線の内のある一本の曲線が閉曲線の場合には、その閉曲線とその前にピックした曲線との交点からその閉曲線とその次にピックした曲線との交点までの間の範囲の内のユーザーが選択した範囲を、その閉曲線の前記所定範囲として取り出すこととしても良い。
【００１０】
【作用】かかるこの発明の連結方法にあっては、ユーザーが、複数の曲線の各々の上の大まかな位置をピックすると、ＣＡＤシステムが、前記ピックした複数の曲線の内の最初にピックした曲線である始線と最後にピックした曲線である終線とについては、他の曲線に対する交点とピック側の端点との間の範囲を所定範囲とし、前記始線および前記終線を除く各曲線については、その曲線とその前にピックした曲線との交点から、その曲線とその次にピックした曲線との交点までの間の範囲をその曲線の前記所定範囲として、前記ピックした複数の曲線のそれら所定範囲を取り出し、それら所定範囲の曲線を連結して一本の曲線を取り出す。
【００１１】従ってこの発明の連結方法によれば、元の複数の曲線の何本かについて取り出す範囲が短い場合でも、ユーザーが、それら複数の曲線の各々の上の大まかな位置をピックするだけで、連結した一本の曲線を、必要な形状で取り出すことができる。
【００１２】なお、二本の曲線間の交点は、通常は一つになるが、複数存在する場合もあり得る。このようにピックした複数の曲線の内のある一本の曲線とその前にピックした曲線との間で複数の交点が存在する場合には、それら複数の交点の内の前記一本の曲線のピック位置に近い交点を、前記一本のピックした曲線とその前にピックした曲線との各々の前記所定範囲を定めるための交点とすることとすれば、それら複数の交点の内の、ユーザーが曲線の取り出し範囲の決定用としたい交点の近くの位置をピックするだけで、ユーザーの必要とする範囲の曲線を取り出すことができる。
【００１３】また、二本の曲線間で存在する複数の交点間の距離が一定値以下の場合には、曲線の取り出し範囲の決定用としたい交点の近くの位置をユーザーが的確にピックするのが難しい場合もあり得る。このようにピックした複数の曲線の内のある一本の曲線とその前にピックした曲線との間で複数の交点が存在するとともにそれら複数の交点間の距離の最小値が所定値以下の場合には、それらの交点が互いに所定距離内のものであることを表示して、それらの交点の内のユーザーが選択した交点を、前記一本のピックした曲線とその前にピックした曲線との各々の前記所定範囲を定めるための交点とすることとすれば、ユーザーの的確なピックが難しいような場合でも、ユーザーの必要とする範囲の曲線を容易に取り出すことができる。
【００１４】さらに、ピックした元の曲線が閉曲線の時には、その閉曲線と前にピックした曲線との交点から、その閉曲線と次にピックした曲線との交点までの間の範囲が二つ存在して、取り出す範囲の自動的な決定が好ましくない場合があり得る。このような場合には、その閉曲線とその前にピックした曲線との交点からその閉曲線とその次にピックした曲線との交点までの間の範囲の内のユーザーが選択した範囲を、その閉曲線の前記所定範囲として取り出すこととすれば、ユーザーの必要とする範囲の曲線を取り出すことができる。
【００１５】
【実施例】以下に、この発明の実施例を図面に基づき詳細に説明する。図１，図２は、この発明の複数曲線の連結方法の一実施例を示すフローチャート、図３はその実施例の方法の実施に用いるＣＡＤシステムを例示する構成図であり、ここにおけるＣＡＤシステムは通常のものと同様、図形等に関する演算処理を行うＣＰＵ（中央処理ユニット）１と、種々のデータを記憶するメモリ２

と、ユーザーのキー操作によってデータを入力するキーボード３と、ユーザーの移動操作やボタン操作によってデータを入力するマウス４と、図形や文字等を画面上に表示するＣＲＴ（画面表示装置）５と、図形や文字等を紙面上に印刷するプリンタ６と、フロッピーディスクドライブ装置等の補助記憶装置７と、上記各構成要素間を接続して各種データを転送するバス８とを具えてなる。

【００１６】図１および図２に示す上記実施例の連結方法は、かかるＣＡＤシステムのＣＰＵ１が、メモリ２および補助記憶装置７の少なくとも一方にあらかじめ記憶している処理プログラムに基づいて実行するものであり、この実施例の方法では、図１に示すように、当該ＣＡＤシステムのユーザーが、ステップ11で線の連結コマンドを選択すると、当該ＣＡＤシステムが、次のステップ12で、ピックした曲線をピック順に管理するための変数Ｘの値をＸ＝０にセットするとともに、処理を終了するか継続するかを示すフラグREの値をRE＝０にセットする。

【００１７】当該ＣＡＤシステムは次いで、ステップ13で、現在のＸの値をＸ＝Ｘ＋１として歩進させて、ユーザーのピック操作を待ち、ユーザーが、連結する元の曲線の内の一本をマウス等の操作でピックすると、次のステップ14で、そのピックした曲線を元の曲線LO(X) とするとともにその曲線のピック位置をＰ(X) として記憶し、次のステップ15で、現在のＸの値がＸ＝１か否かを判断する。そしてＸ＝１の場合には、未だ一本の曲線しかピックしていず曲線の連結ができないので、ステップ16で、その一本の元の曲線LO(1) を連結曲線LP（この段階では最初にピックした曲線である始線のみ）とした後、ステップ13へ戻って上記ステップ13，14の処理を繰り返す。一方、ステップ15での判断の結果、既に上記ステップ13，14を何回か繰り返していてＸ＝１でない場合には、ステップ17で、現在のＸの値に対応する、最後にステップ14で記憶した元の曲線LO(X) と、その前に上記ステップ16または後述するステップ23もしくは24で最後に記憶した連結曲線LPとの交点を求め、その交点の数を変数Ｎの値とする。

【００１８】続くステップ18では、上記Ｎの値が、Ｎ＝０か、Ｎ＝１か、Ｎが０でも１でもないかを判断し、Ｎ＝０の場合には、交点の数が０であるので、ステップ19で、「交点がありません」という内容のワーニング表示を行った後、ステップ14へ戻り、通常のＮ＝１の場合には、ステップ20で、その求めた一個の交点を、最後にステップ14で記憶した元の曲線LO(X) とその前の回のピックによってステップ14で記憶した元の曲線LO(X-1) との間の交点であって取り出し範囲の決定に用いる交点PS(X-1) として記憶した後ステップ22へ進み、Ｎが０でも１でもない場合すなわち複数の交点が存在する場合には、ステップ21で図２に示す複数交点処理を行った後ステップ22へ進む。

【００１９】図２に示す複数交点処理では、先ずステップ31で、上記ステップ17で求まったＮ個の交点をPSA(1)～PSA(N)とし、次のステップ32で、それら複数の交点相互間の距離を計算して、それらの距離の内の最小値をLMとし、次いでステップ33で、そのLMの値が、あらかじめ定めた、ピックの容易な長さの曲線を存在させ得る最小距離以下であるか否かを判断し、LM＞最小距離の場合には、それらの交点間にピックの容易な長さの曲線が存在し得るので、ステップ34で、上記交点PSA(1)～PSA(N)のうち現在の現在のＸの値に対応する、最後にステップ14で記憶したピック位置Ｐ(X) に最も近い交点を、取り出し範囲の決定に用いる交点PS(X-1) とする。一方、ステップ33での判断の結果、LM≦最小距離の場合には、交点間にピックの容易な長さの曲線を存在させ得ない可能性があるので、ステップ35で、交点表示用の変数Ｙの値をＹ＝１にセットするとともに、次の交点を表示するか現在の交点を選択するかを示すフラグPNの値をPN＝０にセットする。

【００２０】続くステップ36では、現在のＹの値に対応する交点PSA(Y)を表示するとともに「NEXT」と「OK」の文字を表示して、ユーザーが「NEXT」をピックした場合にはフラグPNの値をPN＝０とし、ユーザーが「OK」をピックした場合にはフラグPNの値をPN＝１とする。そして次のステップ37では、そのフラグPNの値がPN＝０かPN＝１かを判断して、PN＝０の場合には、現在表示している交点をユーザーが選択しなかったので、次の交点を表示するために、ステップ38で現在のＹの値をＹ＝Ｙ＋１として歩進させ、現在のＹの値がＹ＝Ｎとなっていたら、それ以上歩進させずＹ＝１に戻して、ステップ36へ戻り、ステップ37でPN＝１の場合には、現在表示している交点をユーザーが選択したので、ステップ39で、現在のＹの値に対応する交点PSA(Y)を、取り出し範囲の決定に用いる交点PS(X-1) とした後、図１のフローチャートへ戻ってステップ22へ進む。

【００２１】図１のステップ22では、現在のＸの値がＸ＝２か否かを判断し、Ｘ＝２の場合には、二本の曲線をピックしていて、最初にピックした曲線である始線の範囲を定め得るようになったので、ステップ23で、ステップ16で定めた始線LPの、ステップ20または21で定めた交点PS(1) からピック位置Ｐ(1) 側の端点までの間を取り出して新たな連結曲線LPとし、その連結曲線LPを記憶する。一方、ステップ22での判断の結果、Ｘ＝２でない場合には、ステップ15での判断からＸ＝１でもないのでＸ≧３であって、二本目以降にピックした曲線から所定範囲を取り出すことになるので、ステップ24で、最後にステップ14で記憶した元の曲線LO(X) の一回前に記憶した元の曲線LO(X-1) の、さらにその前に記憶した元の曲線LO(X-2)との交点PS(X-2) から、最後にステップ14で記憶した元の曲線LO(X) との交点PS(X-1) までの間の範囲を取り出し範囲とし、その範囲内の部分を上記元の曲線

LO(X-1) から切り出して、連結曲線LPに用いる曲線LL(X-1) とする。そして次のステップ25では、最後に記憶した連結曲線LPと上記曲線LL(X-1) とを連結した曲線を新たな連結曲線LPとし、その連結曲線LPを記憶する。

【００２２】その後のステップ26では、「終了」と「継続」の文字を表示して、ユーザーが「終了」をピックした場合にはフラグREの値をRE＝１にセットし、「継続」をピックした場合にはフラグREの値をRE＝０にセットする。そして次のステップ27では、そのフラグREの値がRE＝０かRE＝１かを判断して、RE＝０の場合には、曲線のピック処理を継続するために先のステップ13へ戻り、この一方、RE＝１の場合には、最後にピックした曲線である終線の範囲を定め得るようになったので、ステップ28で、現在のXの値に対応する、最後にステップ14で記憶した元の曲線LO(X) の、その一回前に記憶した元の曲線LO(X-1) との交点PS(X-1) からピック位置P(X) 側の端点までの間を取り出して、連結曲線LPに用いる終線LL(X) とし、続くステップ29では、最後に記憶した連結曲線LPと上記曲線LL(X) とを連結した曲線を新たな連結曲線LPとし、その連結曲線LPを記憶する。そしてステップ30では、上記連結曲線LPを最終形状として取り出し、データベース用のデータとして保存する。

【００２３】図４および図５は、上記実施例の方法の適用例をそれぞれ示し、図４に示す適用例は、同図(a) に示すように、図８の場合と同様元の曲線LO_1, LO_2, LO_3 の交点同士が近接しているような場合のもので、この場合に、ユーザーが、同図(b)に示すように元の曲線LO_1 を位置P_1でピックし、次いで同図(c) に示すように元の曲線LO_2 を位置P_2でピックすると、ＣＡＤシステムは、それらの曲線LO_1, LO_2の交点Ａに基づいて曲線LO_1 のその交点Ａからピック位置P_1側の端点までの範囲を始線LP1 として取り出し、次いでユーザーが、同図(d) に示すように元の曲線LO_3 を位置P_3でピックすると、ＣＡＤシステムは、それらの曲線LO_2, LO_3の交点Ｂに基づいて曲線LO_2 のそれら交点Ａ，Ｂ間の範囲を取り出して、上記始線LP_1にその曲線LO_2 の交点Ａ，Ｂ間の範囲を連結した連結曲線LP_2 を取り出し、その後にユーザーが「終了」をピックして選択すると、ＣＡＤシステムは、上記曲線LO_2, LO_3の交点Ｂに基づいて曲線LO_3 のその交点Ｂからピック位置P_3側の端点までの範囲を終線として取り出して、同図(e) に示すように上記連結曲線LP_2 にその終線を連結した連結曲線LP_3 を取り出す。

【００２４】従ってこの実施例の方法によれば、元の曲線LO_2 の、他の曲線LO_1, LO_3との交点Ａ，Ｂ間の範囲が極めて短いためその交点Ａ，Ｂ間で曲線LO_2 をピックすることが困難あるいは不可能な場合でも、ユーザーが、それら複数の曲線の各々の上の大まかな位置をピックするだけで、連結した一本の曲線LP_3 を、必要な形状で取り出すことができる。

【００２５】また図５に示す適用例は、同図(a) に示すように、ピックしたある一本の曲線LO_2 とその前にピックした曲線LO_1 との間で複数の交点Ａ，Ｂが存在する場合のもので、この場合に、ユーザーが曲線LO_2 を位置P_2でピックすれば、ＣＡＤシステムは、図２に示す複数交点処理に基づき、同図(b) に示すようにそのピック位置P_2に近い方の交点Ｂを、曲線LO_1 と曲線LO_2 との各々の取り出し範囲を定めるための交点として、曲線LO_1 につきその交点Ｂまでの範囲を取り出す。そしてその後ユーザーが同図(b) に示すように曲線LO_3 を例えば位置P_3でピックすると、ＣＡＤシステムは、曲線LO_2 につき上記交点Ｂから曲線LO_2 と曲線LO_3 との交点Ｃまでの範囲を取り出して、それら取り出した範囲の曲線を互いに連結した連結曲線LP_2 を取り出す。

【００２６】従ってこの実施例の方法によれば、ピックしたある一本の曲線LO_2 とその前にピックした曲線LO_1 との間で複数の交点Ａ，Ｂが存在する場合でも、それら複数の交点Ａ，Ｂの内の、ユーザーが曲線の取り出し範囲の決定用としたい交点Ｂの近くの位置P_2をピックするだけで、ユーザーの必要とする範囲の曲線を取り出すことができる。

【００２７】なお、図５(c) に示すように、ピックしたある一本の曲線LO_2 とその前にピックした曲線LO_1 との間で複数の交点Ａ，Ｂが存在し、それら複数の交点間の距離が極めて近く、先に述べた所定最小距離以下の場合には、ＣＡＤシステムは、図２に示す複数交点処理に基づき、同図(d) および同図(e) に示すようにユーザーが「NEXT」をピックする度にそれら近接した交点Ａ，Ｂを交互に表示し、ユーザーが「OK」をピックして選択すると、ＣＡＤシステムは、同図(f) に示すようにその「OK」が選択された時に表示していた交点（例えば交点Ｂ）を、曲線LO_1 と曲線LO_2 との各々の取り出し範囲を定めるための交点として、曲線LO_1 につきその交点Ｂまでの範囲を取り出し、その後同図(b) の場合と同様にユーザーが曲線LO_3 を例えば位置P_3でピックすると、ＣＡＤシステムは、曲線LO_2 につき上記交点Ｂから曲線LO_2 と曲線LO_3 との交点Ｃまでの範囲を取り出して、それら取り出した範囲の曲線を互いに連結した連結曲線LP_2 を取り出す。

【００２８】従ってこの実施例の方法によれば、ピックしたある一本の曲線LO_2 とその前にピックした曲線LO_1 との間で複数の交点Ａ，Ｂが存在し、それら複数の交点間の距離が極めて近くて所望の交点Ｂに近い位置を的確にピックするのが困難なような場合でも、ユーザーが所望の交点を選択し得て、必要とする範囲の曲線を容易に取り出すことができる。

【００２９】図６は、上記実施例の方法の変形例を示すものであり、この変形例ではＣＡＤシステムが、先の実施例の手順に加えて、ピックした曲線が閉曲線か否かも判断し、同図(a) に示すように位置P_2でピックした一本の曲線LO_2 が閉曲線の場合には、その閉曲線LO_2 とその

前に位置P_1でピックした曲線LO_1との交点Aから、その開曲線LO_2とその次に位置P_3でピックした曲線LO_3との交点Cまでの間の範囲が二つ存在して、何れの範囲を取り出すかをCADシステムが何らかの基準に基づいて自動的に定めてしまったのでは好ましくない場合があり得ることから、同図(b)に示すようにその開曲線LO_2とその前にピックした曲線LO_1との交点Aからその開曲線LO_2とその次にピックした曲線LO_3との交点Cまでの間の、図では左右二つの範囲の内の、ユーザーが例えば位置P_4のピックによって選択した例えば右側の範囲を、その開曲線LO_2についての取り出し範囲として、連結曲線LP_3を取り出す。

【００３０】従ってこの変形例の方法によれば、ピックした曲線が閉曲線で、その曲線から取り出す範囲が二つ存在し得るような場合でも、ユーザーの必要とする範囲の曲線を取り出すことができる。

【００３１】以上、図示例に基づき説明したが、この発明は上述の例に限定されるものでなく、例えば、上記適用例では三本の曲線を連結する場合を説明したが、この発明の方法によれば、さらに多くの本数の曲線を連結する場合にも、同様にしてそれらの取り出し範囲を定めつつそれらの曲線を逐次連結することができる。

【００３２】

【発明の効果】かくしてこの発明の複数曲線の連結方法によれば、元の複数の曲線の何本かについて取り出す範囲が短い場合でも、ユーザーが、それら複数の曲線の各々の上の大まかな位置をピックするだけで、連結した一本の曲線を、必要な形状で取り出すことができる。

【００３３】なお、ピックした複数の曲線の内のある一本の曲線とその前にピックした曲線との間で複数の交点が存在する場合に、それら複数の交点の内の前記一本の曲線のピック位置に近い交点を、前記一本のピックした曲線とその前にピックした曲線との各々の前記所定範囲を定めるための交点とすることとすれば、それら複数の交点の内の、ユーザーが曲線の取り出し範囲の決定用としたい交点の近くの位置をピックするだけで、ユーザーの必要とする範囲の曲線を取り出すことができる。

【００３４】また、ピックした複数の曲線の内のある一本の曲線とその前にピックした曲線との間で複数の交点が存在するとともにそれら複数の交点間の距離の最小値が所定値以下の場合に、それらの交点が互いに所定距離内のものであることを表示して、それらの交点の内のユーザーが選択した交点を、前記一本のピックした曲線とその前にピックした曲線との各々の前記所定範囲を定めるための交点とすることとすれば、ユーザーの的確なピックが難しいような場合でも、ユーザーの必要とする範囲の曲線を容易に取り出すことができる。

【００３５】さらに、ピックした元の曲線が閉曲線の場合に、その閉曲線とその前にピックした曲線との交点からその閉曲線とその次にピックした曲線との交点までの間の範囲の内のユーザーが選択した範囲を、その閉曲線の前記所定範囲として取り出すこととすれば、ユーザーの必要とする範囲の曲線を取り出すことができる。

【図面の簡単な説明】

【図１】この発明の複数曲線の連結方法の一実施例の処理手順を示すフローチャートである。

【図２】上記実施例の方法の処理手順中の複数交点処理を詳細に示すフローチャートである。

【図３】上記実施例の方法の実施に用いるCADシステムを例示する構成図である。

【図４】上記実施例の方法の一つの適用例を示す説明図である。

【図５】上記実施例の方法の他の適用例を示す説明図である。

【図６】上記実施例の方法の変形例をその適用例と共に示す説明図である。

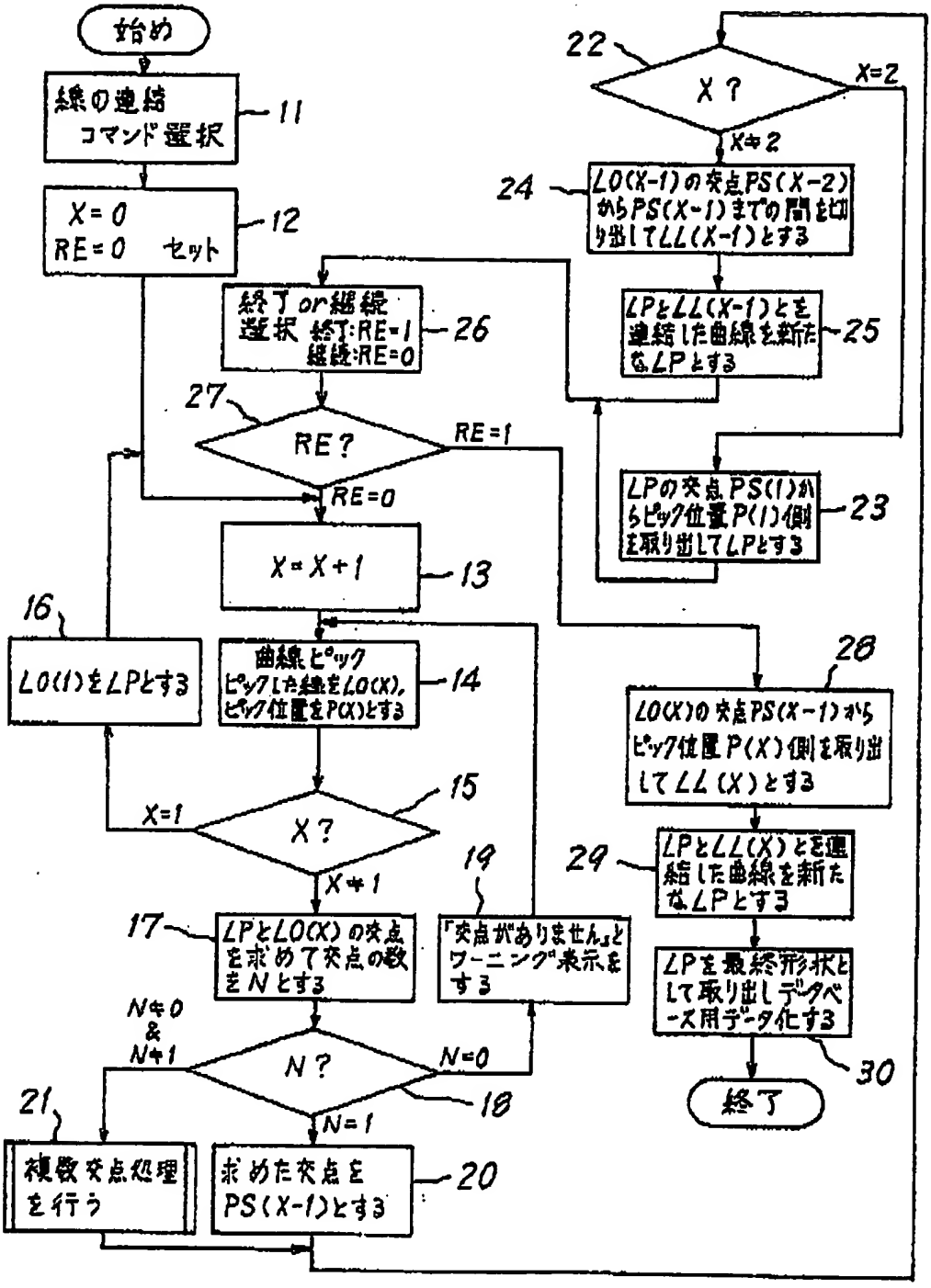
【図７】従来の複数曲線の連結方法を示す説明図である。

【図８】従来の複数曲線の連結方法の問題点を示す説明図である。

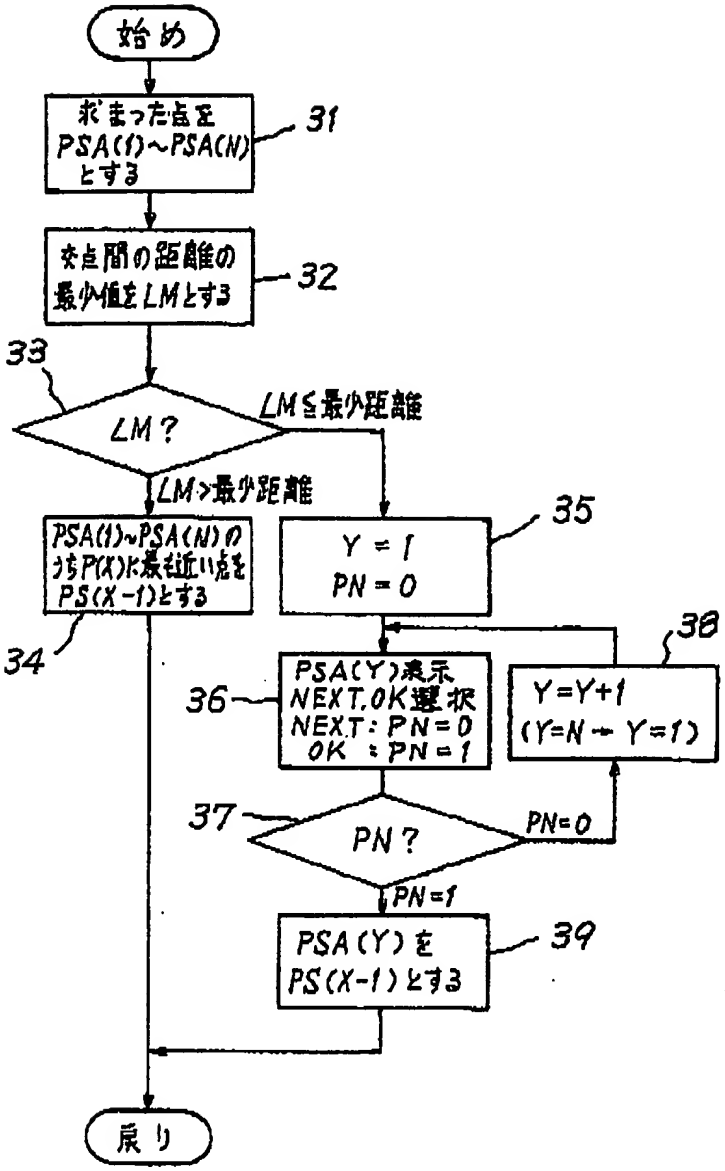
【符号の説明】

１　ＣＰＵ
２　メモリ
３　キーボード
４　マウス
５　ＣＲＴ
６　プリンタ
７　補助記憶装置
８　バス
LO_1, LO_2, LO_3 元の曲線
LP_1, LP_2, LP_3 連結曲線
P_1, P_2, P_3 ピック位置
Ａ，Ｂ，Ｃ　交点

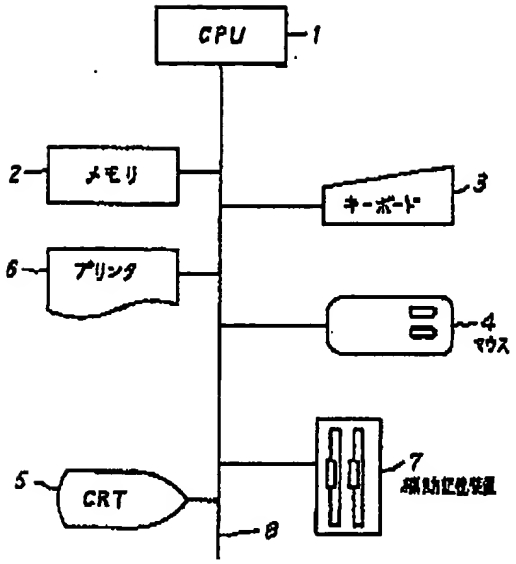
【図１】


始め
線の連結
コマンド選択
11
X=0
RE=0 セット
12
終了or継続
選択 終了:RE=1
継続:RE=0
26
27
RE?
RE=1
RE=0
X=X+1
13
16
LO(1)をLPとする
曲線ピック
ピックした線をLO(X),
ピック位置をP(X)とする
14
15
X?
X=1
X≠1
17
LPとLO(X)の交点
を求めて交点の数
をNとする
19
「交点がありません」と
ワーニング表示を
する
N≠0
&
N≠1
N?
N=0
N=1
18
21
複数交点処理
を行う
求めた交点を
PS(X-1)とする
20
22
X?
X=2
X≠2
24
LO(X-1)の交点PS(X-2)
からPS(X-1)までの間を切
り出してLL(X-1)とする
LPとLL(X-1)とを
連結した曲線を新た
なLPとする
25
LPの交点PS(1)か
らピック位置P(1)側
を取り出してLPとする
23
28
LO(X)の交点PS(X-1)から
ピック位置P(X)側を取り出
してLL(X)とする
29
LPとLL(X)とを連
結した曲線を新た
なLPとする
LPを最終形状と
して取り出しデータベ
ース用データ化する
30
終了

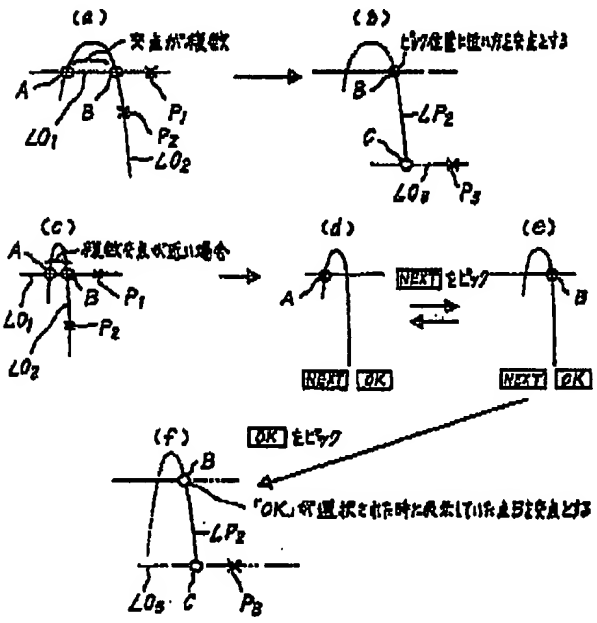
【図2】


始め
求まった点を PSA(1)～PSA(N) とする
31
交点間の距離の最小値をLMとする
32
33
LM?
LM≦最少距離
LM>最少距離
PSA(1)～PSA(N)のうちP(X)に最も近い点を PS(X-1)とする
34
Y=1 PN=0
35
38
PSA(Y)表示 NEXT,OK選択 NEXT: PN=0 OK : PN=1
36
Y=Y+1 (Y=N→Y=1)
37
PN?
PN=0
PN=1
PSA(Y)を PS(X-1)とする
39
戻り

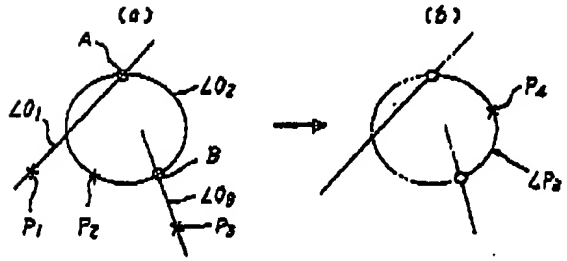
【図3】


CPU
1
2
メモリ
3
キーボード
6
プリンタ
4
マウス
5
CRT
7
8

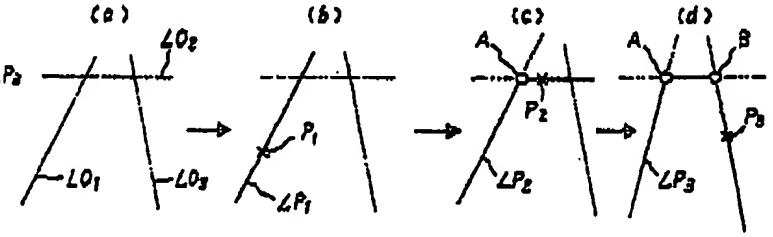
【図5】


(a)
交点が複数
A
B
P1
P2
LO1
LO2
(b)
ピック位置に近い方を交点とする
B
LP2
C
LO3
P3
(c)
複数交点の近い場合
A
B
P1
P2
LO1
LO2
(d)
NEXTをピック
A
NEXT
OK
(e)
B
NEXT
OK
(f)
OKをピック
B
「OK」が選択された時に表示されていた点Bを交点とする
LP2
LO3
C
P3

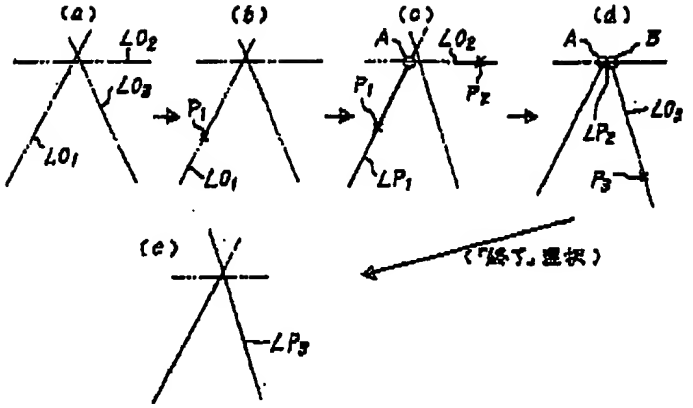
【図6】


(a)
A
LO1
LO2
B
LO3
P1
P2
P3
(b)
P4
LP2

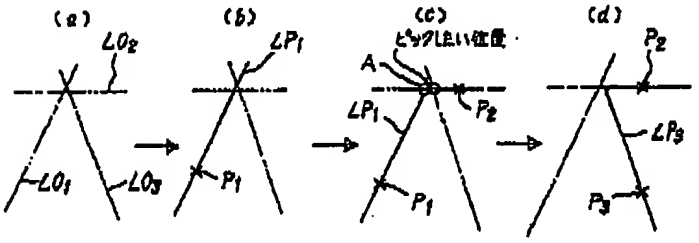
【図7】


(a)
LO2
LO1
LO3
(b)
P1
LP1
(c)
A
P2
LP2
(d)
A
B
P3
LP3

【図４】


(a)
(b)
(c)
(d)
(e)
A
B
P1
P2
P3
LO1
LO2
LO3
LP1
LP2
LP3
(「終了」選択)

【図８】


(a)
(b)
(c)
(d)
ヒットしたい位置
A
P1
P2
LO1
LO2
LO3
LP1
LP3

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 08-263678
(43)Date of publication of application : 11.10.1996

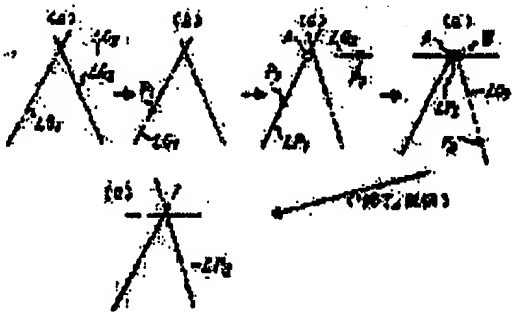
(51)Int.Cl. G06T 11/80
G06F 17/50

(21)Application number : 07-034900
(22)Date of filing : 23.02.1995

(71)Applicant : NISSAN MOTOR CO LTD
(72)Inventor : INOUE HIROYORI

(54) METHOD FOR CONNECTING PLURAL CURVED LINES

(57)Abstract:
PURPOSE: To enable one required-shaped connecting curved line to take out by rough position picks even when a range taken-out by some curved lines is short.
CONSTITUTION: When the respective prescribed ranges of plural curved lines LO1-LO3 are taken out and connected so as to take out one curved line LP3 by the picks in a CAD system, the subject method is characterized in such a way that the range between an end point at the pick position P1 side of the curved line LO1 which is picked firstly and the intersecting point A of the curved line LO1 with the curved line LO2 which is picked next is taken out as a prescribed range concerning the curved line LO1 which is picked firstly, the range between the intersecting point B of the curved line LO3 which is picked lastly with the curved line LO2 which is precedingly picked and the end point at the pick side of the curved line LO3 is taken out as a prescribed range concerning the curved line LO3 which is picked lastly and the range between the intersecting point A of the respective curved liens LO2 with the curved line LO1 which is precedingly picked and the intersecting point B of the curved lines with the curved lines LO3 which are succeedingly picked is taken out as a prescribed range of the curved lines LO2 concerning the respective curved lines LO2 excluding the curved lines which are picked firstly and lastly.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

Translation of Japanese Patent

(43) Date of publication of application: 11 Oct.1996
(11) Publication number: 08-263678
(21) Application number: 07-034900
(22) Date of filing: 23 Feb.1995

(71) Applicant: NISSAN MOTOR CO LTD
(72) Inventor: INOUE HIROYORI
(74) Attorney: SUGIMURA AKIHIDE (+8 others)

(54) METHOD FOR CONNECTING PLURALITY OF CURVED LINES

57) Abstract:

PURPOSE: Concerned with a method for generating a connected curved-line segment by connecting a plurality of curved line segments specified on curved lines selected from a given set of curved lines, and, in particular, with the objective of enabling a user to specify even a short length curved-line segment by picking a curved line at a point on the curved line roughly close to the intended position.

CONSTITUTION: For generating connected curved-line segment LP_3 by taking out a desired segment from each of a plurality of curved lines LO_1 – LO_3 and connecting these curved-line segments into one piece on a CAD system, a desired segment of the first-pick curved line LO_1 is defined as the segment between its crossing point A with the second-pick curved line LO_2 and its pick-position P_1 side end point, the desired segment of the last-pick curved line LO_3 is defined as the segment between its crossing point B with the immediately-preceding-pick curved line LO_2 and its pick-position side end point and the desired segment of each of the curved lines LO_2 picked after the first-pick curved line LO_1 and before the last-pick curved line LO_3 is defined as the segment between the crossing point A of the subject curved line with the immediately-preceding-pick curved line LO_1 and the crossing point B of the subject curved line with the next-pick curved line LO_3.

Claim scopes

Claim 1 A curved-line segment connecting method, for use on a CAD system, according to which a user applies picking operation to a plurality of curved lines to have the CAD system take out desired segments from the curved lines respectively and connect these taken-out segments all together forming a connected curved-line segment of a desired form, wherein, in particular, the method comprises:

defining the desired segment of the first-pick curved line as the segment between the crossing point with the second-pick curved line and the pick-position side end point of the first-pick curved line;

defining the desired segment of the last-pick curved line as the segment between the

crossing point with the immediately-preceding-pick curved line and the pick-position side end point of the last-pick curved line; and

defining the desired segment of each of the curved lines picked after the first-pick curved line and before the last-pick curved line as the segment between the crossing point of the subject curved line with the immediately-preceding-pick curved line and the crossing point of the subject curved line with the next-pick curved line.

Claim 2 The curved-line segment connecting method according to claim 1, in which, when any of the picked curved lines intersects the immediately-preceding-pick curved line at more than one point, the crossing point located nearest to the pick position at which the subject curved line has been picked is assumed to be the crossing point that is used for determining the desired segments taken out respectively from the subject curved line and the immediately-preceding pick curved line.

Claim 3 The curved-line segment connecting method according to claim 2, in which, when any of the picked curved lines intersects the immediately-preceding-pick curved line at more than one point and the shortest distance among distances between crossing points of all the possible pairs of these crossing points is shorter than a pre-assigned distance, all the crossing points separated from any of the other crossing points by a distance shorter than the pre-assigned distance are so indicated on an associated display for allowing the user to select and assign one of the indicated crossing points as the point that is used for determining the desired segments taken out respectively from the subject curved line and the immediately-preceding pick curved line.

Claim 4 The curved-line segment connecting method according to any one of claims 1, 2 and 3, in which, when any of the picked curved lines is a closed loop, the user is allowed to select, as the desired segment taken out from the closed loop, any of the closed loop segments each having one end at a crossing point of the closed loop with the immediately-preceding pick curved line and the other end at a crossing point of the closed loop with the immediately-succeeding pick curved line.

Detailed description of invention

[0001]

Field of industrial application The present invention is concerned with a method for connecting a plurality of line-segments, for use on a computer aided designing (CAD) system, in which a plurality of curved lines (it is assumed in this specification that a curved line includes a straight line) are picked respectively for taking out desired segments from these curved lines respectively and forming a connected curved-line segment of a desired form.

[0002]

Prior art When forming a curved-line segment on a CAD system by taking out desired segments respectively from a plurality of curved lines and connecting them into one, according to the prior technology, a user is required to pick (one kind of mouse operation, in which the pointer is moved to a point on any desired curved line and activated, for instance, by clicking a pre-assigned button on the mouse to single-out the desired curved line) each of the curved lines one after another to have the CAD system take out a connected curved-line segment formed by connecting respectively specified segments of thus picked curved lines, in which the specified segments are determined by the CAD system based on the crossing points between picked curved line pairs and picked positions on the picked curved lines.

[0003] Fig.7 provides an example. When taking out curved-line segment LP_3 by picking three template curved lines LO_1, LO_2 and LO_3 shown as drawing (a) in Fig.7, a user is required to pick point P_1 on template curved line LO_1 and have the CAD system take out curved line LP_1 as shown by drawing (b) in Fig.7. When he next picks point P_2 on template curved line LO_2, the CAD system divides both curved line LP_1 and template curved line LO_2 at the crossing point between curved line LP_1 and template curved line LO_2 and connects picked side portions of the two curved lines (P_1 side of curved line LP_1 and P_2 side of template curved line LO_2) to take out newly formed curved line LP_2 of which the associated picked point is assumed to be the point P_2 as shown by drawing (c) in Fig.7. In the next step, when the user picks point P_3 on template curved line LO_3, the CAD system divides both curved lines LP_2 and LO_3 and connects picked sides of these two curved lines to obtain a connected piece of curved line segments, i.e., connected curved line LP_3.

[0004]

Problem solved by invention It is, however, difficult for any user to pick a template curved line at a correct position in a narrow region along the template curved line, as the precision level achieved for picking operation on a CAD system is not sufficiently high. Hence it is often the case in which the user is required to try a number of times the picking operation or, in the worst case, he may ends up without successfully completing the picking operation. Consequently there are cases in which one cannot have a desired segment taken out correctly for connection to other taken-out segments if the desired segment is very short when working with the CAD system employing the prior-art-technology based method in which curved-line segments to be taken out are determined based on the crossing points and picked positions.

[0005] When, for example, crossing points among template curved lines LO_1, LO_2 and LO_3 are located closely to each other, as shown by drawing (a) in Fig.8, after picking template curved line LO_1 and having the CAD system takes out curved line segment LP_1, as shown by drawing (b) in Fig.8, an user will face with a difficulty. As shown in drawing (c) of the same Fig.8, it is difficult or impossible to pick template curved line LO_2 at a point between crossing points A and B, the crossing points at which template curved line LO_2 meets with other template curved lines LO_1

and LO_3 because the distance between crossings A and B is very short even if a user wishes to have curved-line segment LP_2 taken out by picking template curved line LO_2 that way. As result of this difficulty, if the user picks template curved line LO_2 at a wrong point P_2, as shown by drawing (c) in Fig.8, the CAD system will take out the point P_2 side of template curved line LO_2 with respect to the crossing point B to connect to template curved line LO_3, and consequently, the CAD system will end up taking out connected curved-line segment LP_3. The user, in this manner, fails to have the desired curved-line segment generated.

[0006]

Means for solving problem The objective of the present invention is to provide a connection method that over comes the above-explained problem in an advantageous manner. The method of connecting a plurality of curved-line segments according to the present invention, is for use on a CAD system and assumes a user to apply picking operation to a plurality of curved lines to have the CAD system take out desired segments from these picked curved lines respectively and connect these segments all together forming a connected curved-line segment having a desired form, and the method comprises:

defining the desired segment of the first-pick curved line as the segment between the crossing point with the second-pick curved line and the pick-position side end point of the first-pick curved line;

defining the desired segment of each of the curved lines picked after the first-pick curved line and before the last-pick curved line as the segment between the crossing point of the subject curved line with the immediately-preceding-pick curved line and the crossing point of the subject curved line with the next-pick curved line; and

defining the desired segment of the last-pick curved line as the segment between the crossing point with the immediately-preceding-pick curved line and the pick-position side end point of the last-pick curved line.

[0007] And in a case in which any of the picked curved lines intersects the immediately-preceding-pick curved line at more than one point, it may be configured so that the crossing point located nearest to the pick position at which the subject curved line has been picked is assumed to be the crossing point that is used to determine the desired segments taken out respectively from the subject curved line and the immediately-preceding pick curved line.

[0008] And in a case in which any of the picked curved lines intersects the immediately-preceding-pick curved line at more than one point and the shortest distance among distances between crossing points of all the possible pairs of these crossing points is shorter than a pre-assigned distance, it may be configured so that all these crossing points separated from any of the other crossing points by a distance shorter than the pre-assigned separation distance are so indicated on an associated display for allowing a user to select and assign one of the indicated

crossing points as the point that is used for determining the desired segments taken out respectively from the subject curved line and the immediately-preceding pick curved line.

[0009] And in a case in which any of the picked curved lines is a closed loop, it may be configured so that the user is requested to select, as the desired segment taken out from the closed loop, any of the closed loop segments each having one end at a crossing point of the closed loop with the immediately-preceding pick curved line and the other end at a crossing point of the closed loop with the immediately-succeeding pick curved line.

[0010]

Operation According to the connection method of the present invention, in response to a user picking points respectively on a plurality of curved lines the user wishes to select, wherein the positions of the picking points are chosen only roughly with respect to the preciseness of the position on each of the selected curved lines, the CAD system:

takes out the segment of a picked curved line between the crossing point of the picked curved line with the other picked curved line and the picked point side end of the picked curved line if the picked curved line is the-first pick curved line or the last-pick curved line; and

takes out from each of the curved lines picked after the first-pick curved line and before the last-pick curved line the curved line segment between the crossing point of the subject curved line with the immediately-preceding-pick curved line and the crossing point of the subject curved line with the next-pick curved line,

and connects those segments all together forming a connected curved-line segment.

[0011] According to the connection method of the present invention, as it becomes evident from above, it is possible for a user to have the desired connected curved-line segment of the intended form taken out by picking points respectively on a plurality of curved lines the user wishes to select, only roughly with respect to the preciseness of the position along each of the curved lines.

[0012] A pair of curve lines usually cross each other at one point but may form more crossing points. By having the CAD system to assume the crossing point closest to the picked position among all the concerned crossing points as a crossing point that is used to determine ends of taken-out curved-line segments if there are two or more crossing points between the present pick curved line and the immediately preceding pick curved line, the user becomes only necessary to pick a curved line at a position along the curved line near to the desired crossing point, being unnecessary to pick the curved line exactly at the desired crossing point, to have the CAD system takes out correctly the desired curved line segment from a present pick curbed line.

[0013] There may still be a case in which it is difficult for a user to correctly specify a desired crossing point by picking a curved line of concern at a point near to the desired crossing point when the crossing points between the concerned pair of curved lines are located very close to each other, namely, when they are within a specific distance from any of the other crossing points. If the CAD

system is set to display all concerned crossing points, when two or more crossing points exist, in this way, between a pair of present pick and immediately-preceding pick curbed lines and, in addition, any of the distances between these crossing points is smaller than a pre-assigned distance, to have the user selectively specify the right one for the system to recognize it as the crossing point used for defining ends of the curved line segments taken out respectively from this pair of curved lines among all the crossing points of concern, it becomes possible for the CAD system to take out the correct segment of a curved line even under a situation in which it is difficult for the user to pick a curved line at a right position with a required precision level of accuracy.

[0014] There may yet be another case in which a template curved line of a pick is a closed loop and it is not desirable to allow the system to select automatically one of the two curved line segments that are defined as segments linking between the two crossing points formed on the closed loop, one with the immediately-preceding pick curved line and the other with the immediately-succeeding pick curved line. It is possible to have the desired one of the curved line segments taken out by setting the CAD system to take out one selectively specified by the user from the two segments defined between the crossing point with the preceding-pick curved line and the crossing point with the succeeding-pick curved line.

[0015]

Embodiments We will explain in more detail about embodiments of the present invention using a number of drawings. Figs.1 and 2 provide flowcharts associated with a curved line connection method as an embodiment of the present invention. Fig.3 provides a configuration of an exemplar CAD system used for implementing this embodiment method. The CAD system, similarly to those of general use, comprises a CPU (Central Processing Unit) 1 for processing data such as one representing a drawing, a memory 2 for storing various kinds of data, a keyboard 3 on which a user operates keys for inputting data, a mouse 4 of which the position is moved and/or the buttons are activated by a user for inputting data, a CRT (Screen Display Unit) 5 for displaying things such as drawings and characters, a printer 6 for printing on a piece of paper things such as drawings and characters, an auxiliary storage unit 7 such as a floppy disk drive and a bus 8 connecting between these configuration components for conveying various kinds of data.

[0016] The method of connecting curved-line segments of the embodiment described above and shown by drawings in Figs.1 and 2 is implemented by a CPU 1 contained in the CAD system, in which the CPU 1 operates accordingly to a processing program stored beforehand in at least one of the memory 2 and the auxiliary storage unit 7. In the case of this embodiment, as shown by the drawing in Fig.1, when a user of the CAD system selects a line-connecting command in step 11, the CAD system, in step 12, which is the step following step 11, sets the value of X to zero, X=0, in which the variable X is defined for use in managing picked curved-lines in a manner associated with the order of them being picked, and at the same time, sets the value of RE to zero, RE=0, in which

the flag value RE is defined as one to indicate whether the CAD system terminates or continue the associated process.

[0017] The CAD system associated with the present invention, then in step 13, sets the current value X to X=X+1, namely increases the value X by one and waits for the user performing the picking operation next, and once the user selects one of the template curved lines prearranged for use in the connection processes, the CAD system in step 14, names and memorizes both the picked curved line as template curved line LO(X) and the picked position on the picked curved line as position P(X). In the next step, step 15, it determines if the value of X is currently 1. If it is determined as X=1, then in step 16, picked template curved line LO (1) is assumed as connected curved-line segment LP (which comprises, in this step, only of the first pick curved line, which constitutes the starting line) because in this step the selected curved line is only one and no other curved line is selected to which it may be connected to and the process is moved back to step 13 to perform steps 13 and 14 in a repeating manner. On the other hand, in step 15, if it is determined that X is not one, steps 13 and 14 having already been performed in repeat, the CAD system proceeds to step 17 in which the CAD system determines a crossing point or crossing points between template curved line LO(X) picked last in step 14 corresponding to the current value of X and the connection curved line LP that has been last memorized in the immediately preceding step, step 16, or in one of steps 23 and 24, of which the detail is explained later, and assigns the number of all the associated crossing points to variable N.

[0018] In the next step, step 18, it determines whether variable N is zero, one or else. If it is determined to be N=0, it displays a warning message which means "no crossing points exists", in step 19 and then moves back to step 14. If it is determined to be N=1, which is the most ordinary situation, in step 20, the CAD system memorizes the determined crossing point as crossing point PS(X–1) used for determining ends of both template curved-line LO(X) memorized in the last performing of step 14 and template curved-line LO(X–1) memorized in the one-before-the-last performing of step 14 and then moves to step 22. If it is determined to be neither N=0 nor N=1, i.e., if it is determined to be in a situation in which there are more than one crossing points, the CAD system, in step 21, performs the plural crossing point handling process shown by the drawing in Fig.2 and then moves to step 22.

[0019] The plural crossing point handling process shown in Fig.2 comprises step 31, in which the CAD system distinguishes the N crossing points determined in step 17, as described before, by identifications, PSA(1) – PSA(N), and in the next step, step 32, it calculates distances between these crossing points to call the shortest distance value as LM. In the following step, step 33, it determines whether the value of LM is shorter than a pre-assigned minimum required distance between a pair of crossing points for a user to be able to pick comfortably the curved-line segment lying in between. If LM is longer than the pre-assigned minimum required distance, in step 34, it

selects the crossing point most closely positioned to pick position P(X) memorized in the last performing of step 14 as the crossing point PS(X–1) that is used for determining ends of taken-out curved-line segments, because the curved-line segments existing in between any pair of crossing points PSA(1) – PSA(N) are long enough for a user to perform comfortably the picking operation. In it is determined that LM is equal to or shorter than the pre-assigned minimum required distance in step 33, then in step 35, the CAD system sets variable Y to zero, in which variable Y is defined as a variable used for displaying the crossing points and at the same time set flag PN to zero, in which the flag is configured to indicate whether the CAD system has another crossing point displayed or selects currently displayed crossing point, because the length of curved-line segments existing between these crossing points may not be long enough for a user performing comfortably the picking operation.

[0020] In the following step, step 36, the CAD system has crossing point PSA(Y), which corresponds to the current value Y, displayed together with words, "NEXT" and "OK". When the user picks "NEXT", it assigns value 0 to flag PN, PN=0, and alternatively, if the user picks "OK", it assigns value 1 to flag PN; PN=1. Then in step 37, it determines if the flag is set to PN=0 or to PN=1. If it determines that the flag is set to PN=0, in step 38, it increases the value of Y to Y+1 so as to have the next crossing point is displayed because PN=0 indicates that the user has not selected the then displayed crossing point. At this point, however, if it finds the value of Y is already equals to N, Y=N, it sets the value of Y to 1, i.e., it sets as Y=1, instead of increasing the value to any larger value than N, and moves back to step 36. If it determines, in step 37, that the flag is set to PN=1, then in step 39, it assumes crossing point PSA(Y) as crossing point PS(X–1) used for determining taken-out curved-line segments, because PN=1 indicates that the user has selected the currently displayed crossing point, and then moves to step 22 shown in Fig.1.

[0021] In step 22 shown by drawing in Fig.1, it determines whether the value of X is currently 2, i.e., X=2. If it determines that X=2 stands for the current situation, in step 23, it takes out the portion of starting line LP determined in step 16, of which the portion lies between crossing point PS(1) determined in step 20 or 21 and the pick position P(1) side end of starting line LP, and assumes and memorizes this portion as newly assumed connected curved-line segment LP, because X=2 indicates there are two curbed lines having been selected. On the other hand, if it determines that X does not equal to 2 in step 22, X must be 3 or larger because it has already been determined that X is not 1 in step 15 and, therefore, the taken-out curved line segments must occur only from curved lines of the second pick or of later picks than the second pick. And it, in step 24, takes out a portion of template curved-line LO(X–1) defined as the portion between crossing point PS(X–2) representing its crossing point with template curved-line LO(X–2) memorized earlier by twice of performing than template curved-line LO(X) memorized in the last performing of step 14 and crossing point PS(X–1) representing its crossing point with template curved-line LO(X) memorized in the last performing of

step 14, and calls this taken-out portion as curve-line segment LL(X–1), which is employed for forming connected curved-line segment LP. In the following step, step 25, the CAD system connects the last memorized connected curved-line segment LP and the above described segment, i.e., curved-line segment LL(X–1) to form newly determined connected curved-line segment LP and memorizes it in the CAD system.

[0022] In the step that follows the above step, i.e., in step 26, it has phrases, "end operation" and "continue operation" displayed so that the user can select either one. If the user selects "end operation", it sets flag RE to 1 (RE=1) while if the user selects "continue operation", it sets flag RE to 0 (RE=0). In step 27, then, it determines whether the flag is set to RE=0 or to RE=1. If it finds the flag is set as RE=0, it goes back to step 13 to continue operation of the curved-line picking process. On the other hand, if it finds the flag is set as RE=1, it, in step 28, takes out the portion of template curved-line LO(X) corresponding to the current value of X and memorized in the last performing of step 14, in which the portion is defined as the segment between its crossing point PS(X–1) with template curved-line LO(X–1) memorized in the once earlier performing of step 14 and the picked position side end of template curved-line LO(X), because RE=1 indicates the process is at the stage of determining the portion taken out from the last pick curved-line that represents the last portion of the connected curved-line segment. It further calls thus taken-out curved-line segment as last-curved-line segment LL(X) for use in forming connected curved-line segment LP and, in step 29, it connects the last memorized connected curved-line segment LP and the above-described last-curved-line segment LL(X) to form new connected curved-line segment LP, which it memorizes within the CAD system. In step 30, above-described connected curved-line segment LP is singled out as that with its completed form and stored in a database as an entry to the database.

[0023] Drawings shown in Figs.4 and 5 illustrate some examples of applying the method according to the above-described embodiment. The application examples found in Fig.4 are concerned with a situation in which, similarly to the situation associated Fig.8, the crossing points among template curved lines LO_1, LO_2 and LO_3 are closely located. Under this situation, in response to a user picking template curved line LO_1 at position P_1 as drawing (b) illustrates and further the user picking template curved line LO_2 at position P_2 as drawing (c) illustrates, the CAD system takes out the portion of curved-line LO_1 between its connection point A with curved-line LO_2 and its picked position P_1 side end point as a segment that forms the starting portion LP_1. In response to a user, then, picking template curved line LO_3 at position P_3 as drawing (d) illustrates, the CAD system takes out the portion of curved-line LO_2 between its crossing point A with curved-line LO_1 and its crossing point B with curved-line LO_3 and forms and takes out connected curved-line segment LP_2 by connecting the curved line segment between the crossing point A and crossing point B of template curved line LO_2 with the above-described starting portion LP_1. When the user, then, picks and selects "end operation", the CAD system takes out the portion of curved line LO_3 between

its crossing point B with curved line LO_2 and the pick position P_3 side end of curved line LO_3 as a portion that constitutes the ending portion and connects this ending portion to the above-described segment, connected curved-line segment LP_2 to form and single out connected curved-line segment LP_3.

[0024] It becomes clear from the above review of the operation according to the method of this embodiment that even under a situation in which it is difficult if not impossible for a user to pick template curved line LO_2 at a position between crossing points A and B, which are crossing points of template curved line LO_2 with two other template curved lines LO_1 and LO_3, because the distance between these crossing points A and B is very short, it is possible for the user to have connected curved-line segment LP_3 taken out in its desired form by him picking relevant curved lines at positions he roughly selects on these curved lines respectively.

[0025] In the case of an example operation shown by drawing (a) in Fig.5 associated with the embodiment method, picked curved-line LO_2 has more than one crossing point, crossing points A and B, with preceding-pick curved line LO_1. Under this situation, according to this embodiment method, the CAD system follows the rule for handling a plurality of crossing points shown by the drawing in Fig.2, i.e., in response to the user picking curved-line LO_2 at position P_2, the CAD system selects crossing point B, the crossing point located closer to position P_2, as the crossing point that is used for determining segments taken out from curved-lines LO_1 and LO_2 as illustrated by drawing (b) in Fig.5. The CAD system, then, takes out the curved line LO_1 segment ending at crossing point B. In the following action, if the user picks curved line LO_3 at position P_3 as illustrated by drawing (b) in Fig.5, the CAD system takes out the segment of curved line LO_2 between the above described crossing point, crossing point B, and the point at which curved lines LO_2 and LO_3 cross each other, i.e., crossing point C and eventually forms and singles out connected curved-line segment LP_2 by connecting all these taken-out curved-line segments.

[0026] It becomes clear from the above review of the operation according to the method of this embodiment that even under a situation in which a picked curved line, curved line LO_2 has more than one crossing point, crossing points A and B, with preceding-pick curved line LO_1, it is possible for the user to have a connected curved-line segment singled out only by picking a position, position P_2, which is located closer to the crossing point, crossing point B, that he needs to use for determining curved-line segments to be taken out.

[0027] Apart from the above-described operations, under a situation, as shown by drawing (c) in Fig.5, in which a picked curved line, curved line LO^2 has more than one crossing point, crossing points A and B, with preceding-pick curved line LO_1 and, further, these crossing points are closely located to each other with associated separation distances being shorter than a pre-assigned minimum required distance of which the implication is provided earlier in this specification, the CAD system follows the rule for handling a plurality of crossing points shown by the drawing in

Fig.2, i.e., in response to the user picking "NEXT" every time, the CAD system has one of the crossing points, crossing points A and B, displayed one after another as illustrated by drawings (d) and (e) in Fig.5 so as to have the user pick "OK" for one of these crossing points. In response to the user picking "OK" to a crossing point, the CAD system assumes the then displayed crossing point (say crossing point B) among the plurality of crossing points between curved lines LO_1 and LO_2 as the crossing point to be used for determining curved-line segments to be taken out, as illustrated in drawing (f) in Fig.5. The CAD system, accordingly, takes out the segment leading to crossing point B of curved line LO_1 and later, when the user picks curved line LO_3 at a position, say at position P_3, takes out the curved-line LO_2 segment, similarly to the operation shown by drawing (b) in Fig.5, starting from crossing point B and ending at crossing point C that is the crossing point of curved line LO_2 with curved line LO_3, and eventually forms and singles out connected curved-line segment LP_2 by connecting together these taken-out curved-line segments.

[0028] It becomes clear from the above review of the operation according to the method of this embodiment that even under a situation in which a picked curved line, curved line LO_2, has more than one crossing point, crossing points A and B, with preceding-pick curved line LO_1, and further, these crossing points are so closely located to each other that it is difficult to pick properly a position nearest to a desired crossing point, crossing point B, it is possible for the user to have a desired connected curved-line segment singled out by choosing the desired crossing point easily.

[0029] Drawings in Fig.6 are concerned with an example representing an operation according to a modification of the embodiment method described above. According to this example associated with the modification of the embodiment method, the CAD system, further to the operation steps associated with the embodiment method, determines whether a picked curved line is a closes loop. And on finding curved line LO_2 picked at position P_2 being a closed loop, as illustrated by drawing (a) in Fig.6, it singles out connected curved-line segment LP_3 by taking out the side a user has selected by picking a due position, position P_4, from the two curved-line segments formed along closed loop LO_2 spanning between crossing point A that is its crossing point with preceding pick curved line LO_1 and crossing point C that is its crossing point with succeeding-pick curved line LO_3 as illustrated by drawing (b) in Fig.6, because it is impossible to have a desired side selected always by configuring the CAD system to follow a pre-assigned selection rule and select automatically one of the two alternative curved-line segments becoming available as the curved-line segments spanning between crossing point A of closed loop LO_2 with preceding-pick curved line LO_1 that has been picked at position P_1 and crossing point B of closed loop LP_2 with succeeding-pick curved line LO_3 that has been picked at position P_3.

[0030] It becomes clear from the above review of the operation according to the method of this modified embodiment that even under a situation in which a picked curved line is a closed loop and two alternative curved-line segments are formed for taking out from the picked curved line, it is

possible for the user to have a desired connected curved-line segment taken out.

[0031] We have described, in the foregoing, about the present invention by following example cases shown in drawings but the present invention is not limited to the features associated with these example cases. For example, while example cases described in the foregoing are associated with connecting three curbed lines, it is possible to have curved-line segments determined and connected consecutively if it is required to connect any larger number of curved lines in the same manner the present invention method is applied to these example cases.

[0032]

Benefits of invention According to the method of the present invention for connecting a plurality of curved lines, even under a situation in which curved-line segments necessary to take out are short with respect to some of a plurality of template curved lines, it is possible for a user to have a connected curved-line segment singled out in a desired form only by picking a roughly determined position along each length of the template curved lines of concern.

[0033] By configuring a CAD system, when in a situation in which a picked curved line has more than one crossing point with an immediately preceding-pick curved line, to take out the crossing point located closest to the position at which the current pick curved line has been picked it becomes possible for the user to have a connected curved-line segment singled out only by picking a position, which is located closest to the crossing point that he needs to use for determining curved-line segments to be taken out.

[0034] By configuring a CAD system, when in a situation in which a picked curved line has more than one crossing point with an immediately preceding-pick curved line, and further, the shortest distance among those measured between these crossing points is shorter than a pre-assigned distance, to have these crossing points displayed together with a statement indicating that the associated separation distances are shorter than the pre-assigned distance and to assume the crossing point selected by a user from those displayed as the crossing point used for determining the desired take-out segments of the current pick and the immediately-preceding pick curved lines, it becomes possible for the user to have a desired connected curved-line segment singled out even if it is difficult for the user to perform picking operation properly.

[0035] And further, by configuring a CAD system, when in a situation in which a picked curved line is a closed loop, to assume the side a user has selected from the curved-line segments formed along the closed loop and between its crossing point with the immediately preceding-pick curved line and its crossing point with the succeeding-pick curved line as the desired curved-line segment to be taken out from the closed loop, it becomes possible for the user to have a desired curved-line segment taken out.

Brief explanation of drawings

[Fig.1] Flowchart indicating process flow associated with an embodiment of the present invention

method for connecting plurality of curved-line segments

[Fig.2] Flowchart indicating process flow of a plural crossing point handling process included in the process flow associated with the embodiment method shown in Fig.1

[Fig.3] Drawing of example configuration of CAD system employed for implementing the embodiment method shown in Fig.1

[Fig.4] Drawing for explaining an example operation according to the embodiment method shown in Fig.1

[Fig.5] Drawing for explaining another example operation according to the embodiment method shown in Fig.1

[Fig.6] Drawing for explaining both a method obtained by modifying the embodiment method shown in Fig.1 and an example operation according to this modified method

[Fig.7] Drawing for explaining the prior-art method for connecting plurality of curved-line segments.

[Fig.8] Drawing for explaining problems associated with the prior-art method for connecting plurality of curved-line segments

Explanation to item codes

1 CPU,	2 Memory,	3 Ksyboard,	4 Mouse, 5 CRT,
6 Printer,	7 Auxiliary storage unit,		8 Bus,
LO1, LO2, LO3	Template curved lines,	LP1, LP2, LP3	Connected curved line segments,
P1, P2, P3	Pick positions,	A, B, C	Crossing points,

Fig.1

Start of operation

11: Select a line-connecting command.

12: Set to X=0, RE=0.

13: X=X+1

14: Pick a curved line. Picked line is called LO(X) and picked position is called P(X).

15: X?

16: Set LO(1) as LP.

17: Obtain crossing points of LP with LO(X) and set N to the number of obtained crossing points.

18: N?

19: Display warning message, "No crossing points found".

20: Call the obtained crossing point as PS(X-1).

21: Perform a plural crossing point handling process.

22: X?

23: Take out segment of LP starting from crossing point PS(1) and continuing to the pick-position-P(1) side end of LP, and call the taken-out segment as LP.

24: Take out segment of LO(X-1) starting from crossing point PS(X-2) and continuing to crossing point PS(X-1), and call the taken-out segment as LL(X-1).

25: Call the connected curved-line segment obtained by connecting LP and LL(X-1) newly as LP.

26: Select "end operation" or "continue operation". End operation: RE=1, continue operation: RE=0.

27: RE?

28: Take out segment of LO(x) starting from crossing point PS(X-1) and continuing to the pick-position-P(X) side end of LO(x), and call the taken-out segment as LL(X).

29: Call the connected curved-line segment obtained by connecting LP and LL(X) newly as LP.

30: Single out LP as to represent the final form and store in a database as an entity of the database.

End of operation

Fig.2

Start of operation

31: Call obtained crossing points as PSA(1) – PSA(N)

32: Call the minimum distance among those associated with all the possible crossing point pairs as LM.

33: LM?

To the rightward direction from 33: LM = or < (Minimum distance)

To the downward direction from 33: LM > (Minimum distance)

34: Call the crossing point closest to position P(X) as PS(X-1) among PSA(1)–PSA(N).

35: Y=1, PN=0

36: Display PSA(Y). Select "NEXT" or "OK". NEXT: PN=0, OK: PN=1.

37: PN?

38: Y=Y+1, (Y=N → Y=1)

39: Set PSA(Y) as PSA(X=1).

Return to the main operation process.

Fig.3

1 CPU, 2 Memory, 3 Keyboard, 4 Mouse, 5 CRT

6 Printer, 7 Auxiliary storage unit 8 Bus

Fig.4

The arrow directing drawing (e) from drawing (d) is explained as "("End operation" is selected.)".

Fig.5

In drawing (a), crossing points are explained as "more than one crossing point are formed".

In drawing (b), crossing point B is explained as "call the point closer to pick position as crossing point".

In drawing (c), crossing points are explained as "if these plurality of crossing points are located close to each other".

Between drawings (d) and (e), it is explained as "each time when NEXT is picked, the display is switched between forms indicated by drawing (d) and drawing (c)".

Between drawings (e) and (f), a long arrow is shown indicating "when "OK" is picked, the point, point B, displayed at the time of "OK" has been picked is called the crossing point.

Fig.6 (No Japanese letters used)

Fig.7 (No Japanese letters used)

Fig.8

In drawing (c), the narrow space between the two crossing points is explained as "Position desired to pick".

= End =

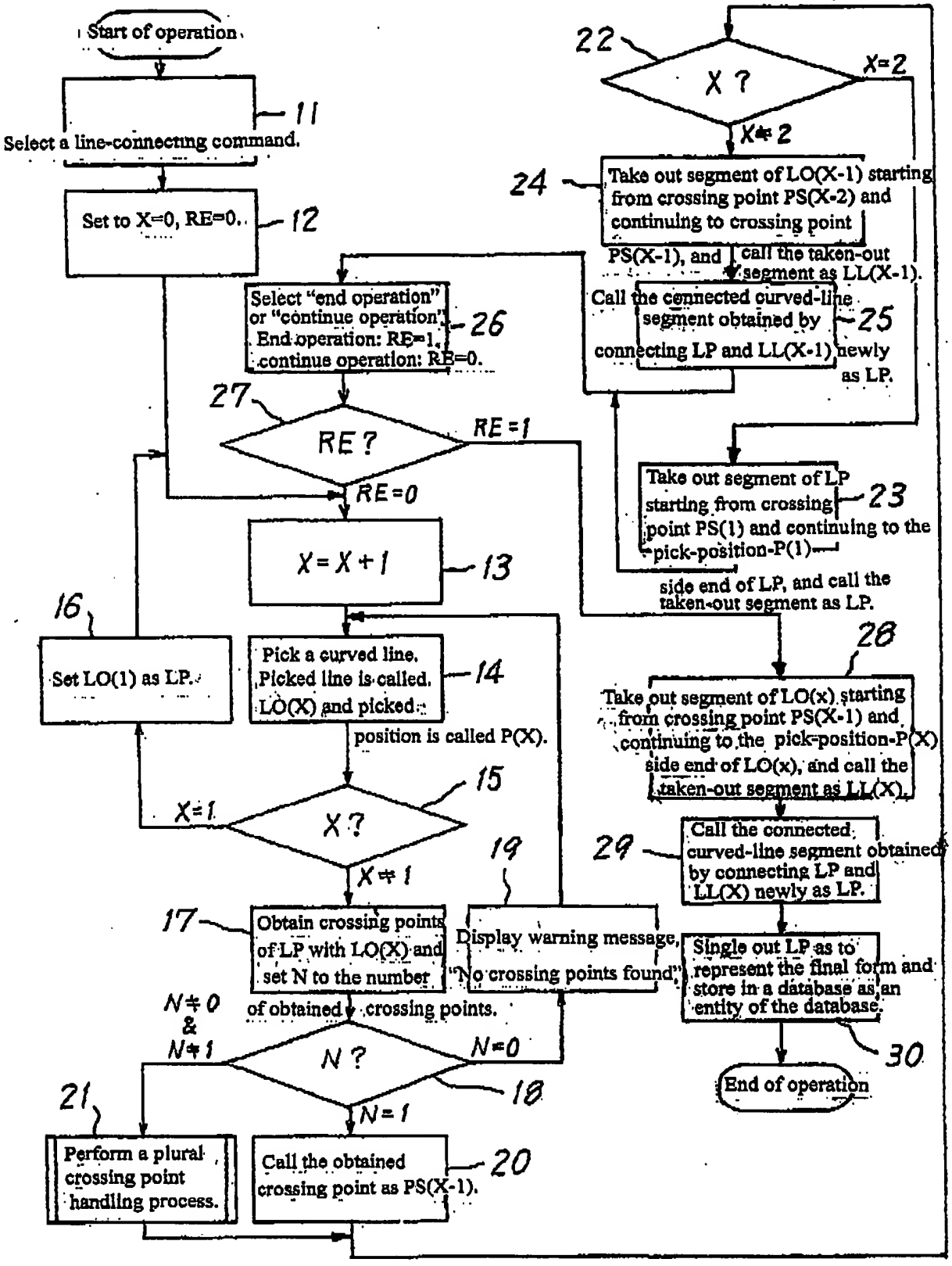

Start of operation
11
Select a line-connecting command.
12
Set to X=0, RE=0.
26
Select "end operation" or "continue operation". End operation: RE=1, continue operation: RE=0.
27
RE ?
RE=1
RE=0
13
X = X + 1
16
Set LO(1) as LP.
14
Pick a curved line. Picked line is called. LO(X) and picked position is called P(X).
15
X ?
X=1
X≠1
19
17
Obtain crossing points of LP with LO(X) and set N to the number of obtained crossing points.
Display warning message, "No crossing points found".
N≠0 & N≠1
N ?
N=0
N=1
18
21
Perform a plural crossing point handling process.
20
Call the obtained crossing point as PS(X-1).
22
X ?
X=2
X≠2
24
Take out segment of LO(X-1) starting from crossing point PS(X-2) and continuing to crossing point PS(X-1), and call the taken-out segment as LL(X-1).
25
Call the connected curved-line segment obtained by connecting LP and LL(X-1) newly as LP.
23
Take out segment of LP starting from crossing point PS(1) and continuing to the pick-position-P(1) side end of LP, and call the taken-out segment as LP.
28
Take out segment of LO(x) starting from crossing point PS(X-1) and continuing to the pick-position-P(X) side end of LO(x), and call the taken-out segment as LL(X).
29
Call the connected curved-line segment obtained by connecting LP and LL(X) newly as LP.
Single out LP as to represent the final form and store in a database as an entity of the database.
30
End of operation

Fig.1

Fig.2

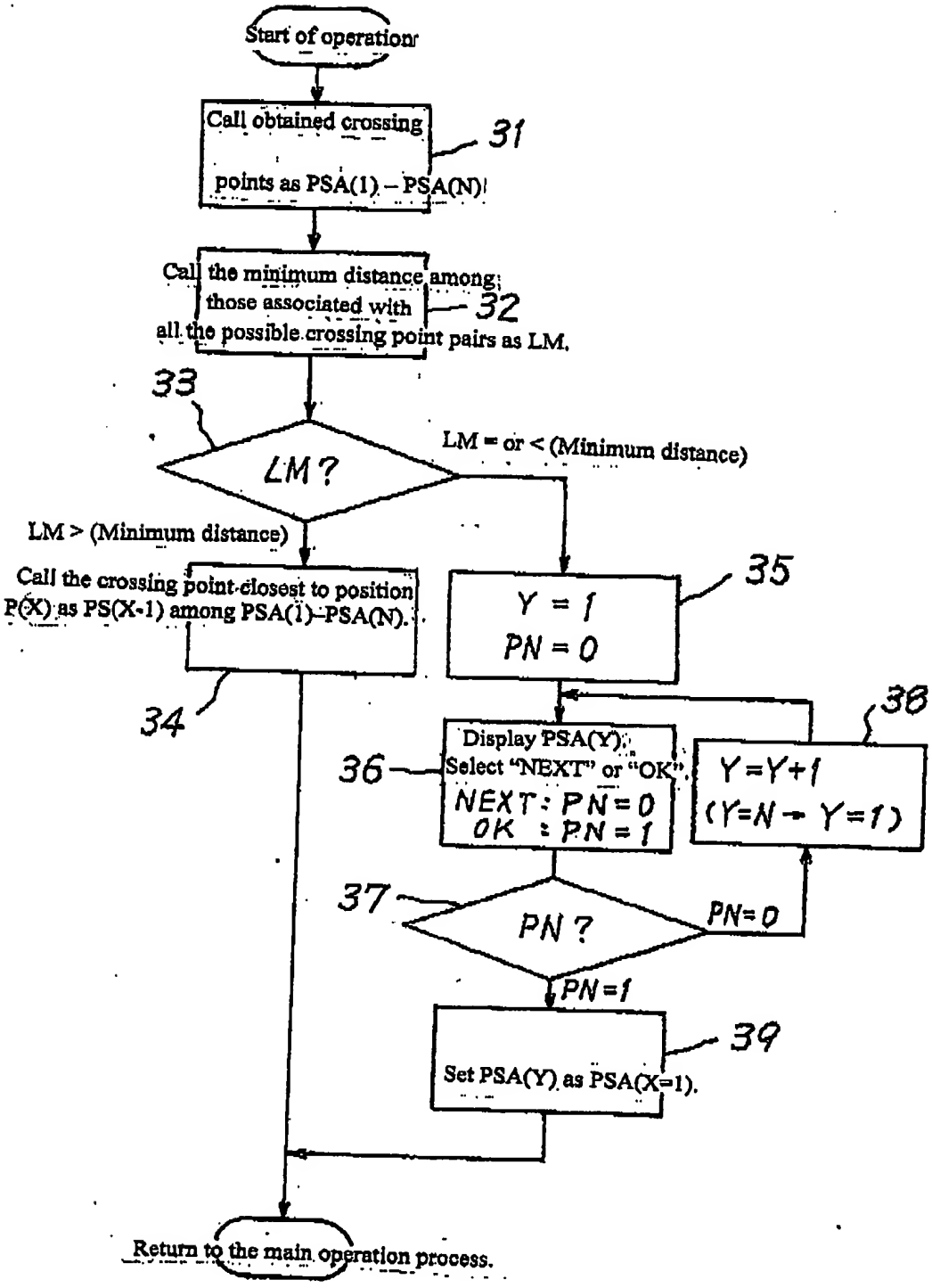

Start of operation
Call obtained crossing points as PSA(1) – PSA(N).
31
Call the minimum distance among those associated with all the possible crossing point pairs as LM.
32
33
LM ?
LM = or < (Minimum distance)
LM > (Minimum distance)
Call the crossing point closest to position P(X) as PS(X-1) among PSA(1)–PSA(N).
34
Y = 1
PN = 0
35
Display PSA(Y). Select "NEXT" or "OK".
NEXT : PN = 0
OK : PN = 1
36
Y=Y+1
(Y=N → Y=1)
38
PN ?
PN=0
PN=1
37
Set PSA(Y) as PSA(X=1).
39
Return to the main operation process.

Fig.3

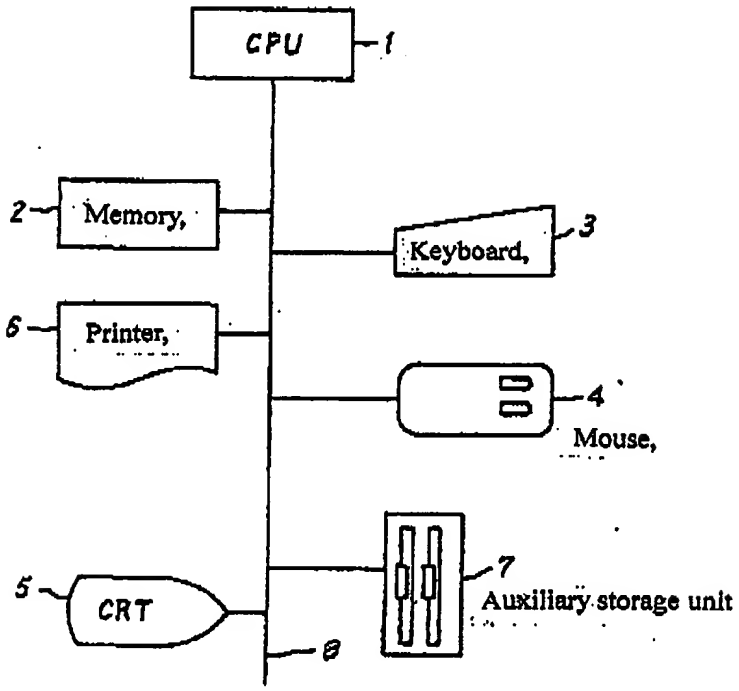
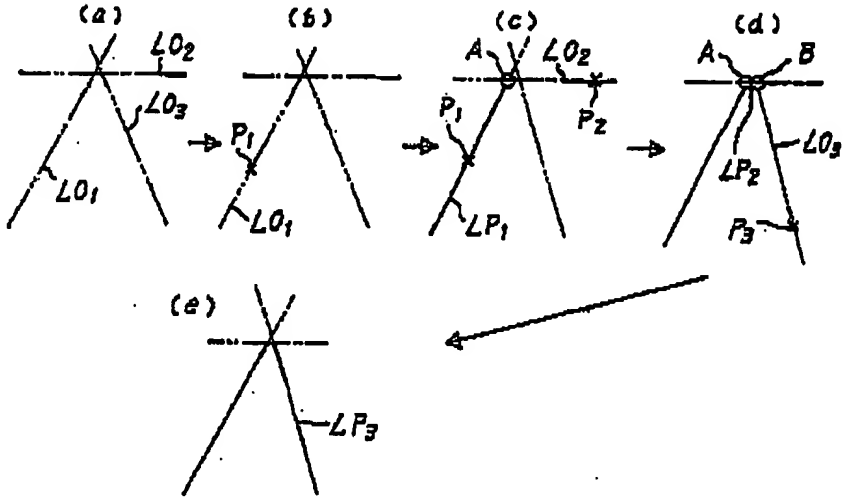

CPU
1
2
Memory,
Keyboard,
3
6
Printer,
4
Mouse,
7
Auxiliary storage unit
5
CRT
8

Fig.4

The arrow directing drawing (e) from drawing (d) is explained as "("End operation" is selected.)".



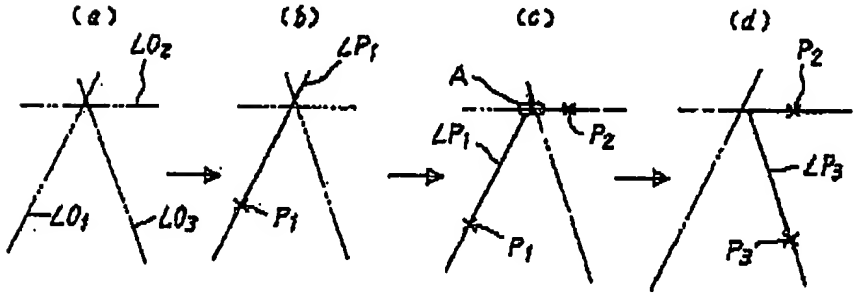
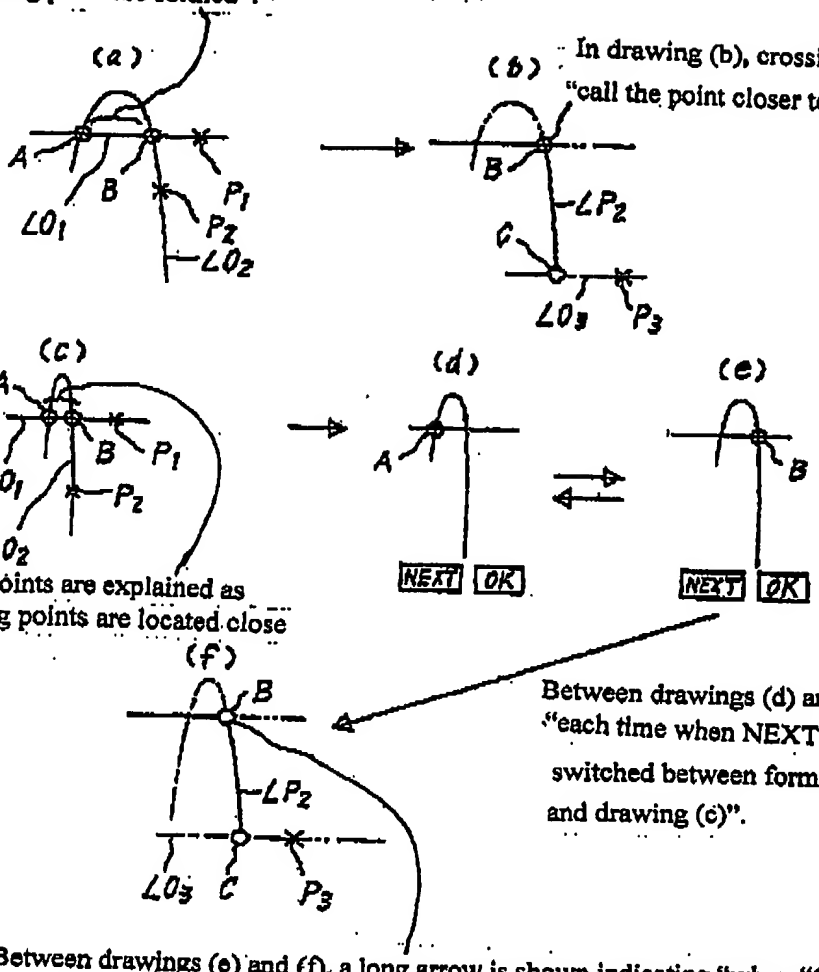


Fig.8

In drawing (c), the narrow space between the two crossing points is explained as "Position desired to pick".

In drawing (a), crossing points are explained as "more than one crossing point are formed".

Fig.5



In drawing (b), crossing point B is explained as "call the point closer to pick position as crossing point".

In drawing (c), crossing points are explained as "these plurality of crossing points are located close to each other".

Between drawings (d) and (e), it is explained as "each time when NEXT is picked, the display is switched between forms indicated by drawing (d) and drawing (c)".

Between drawings (e) and (f), a long arrow is shown indicating "when "OK" is picked, the point; point B, displayed at the time of "OK" has been picked is called the crossing point.

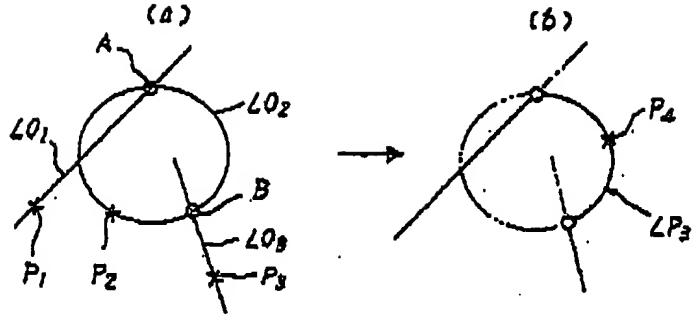

(a)
A
LO_2
LO_1
B
LO_3
P_1
P_2
P_3
(b)
P_4
LP_3

Fig.6

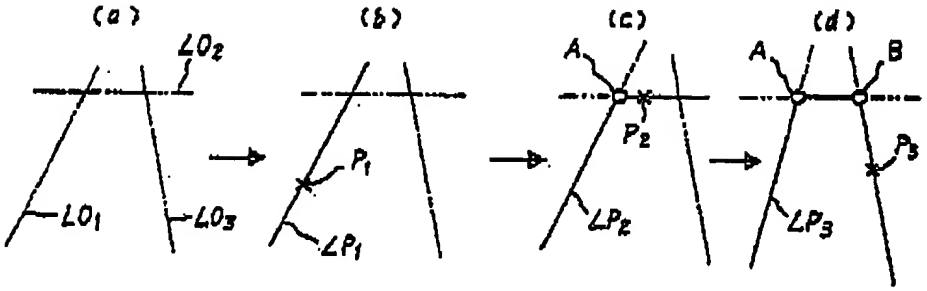

(a)
LO_2
LO_1
LO_3
(b)
P_1
LP_1
(c)
A
P_2
LP_2
(d)
A
B
P_3
LP_3

Fig.7